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ABSTRACT

The purpose of this study was to assess relationships among prior mathematics educational experience, anticipated teaching style, and anxiety for teaching mathematics. Pre-services elementary teachers (n=28) completed questionnaires measuring the style by which they had been taught mathematics in elementary school, anticipated mathematics teaching style, and anxiety for teaching mathematics (State-Trait Personality Inventory with changed heading) at the beginning of a mathematics methods course. The two latter measures were re-administered at the completion of the course. Teaching style was categoried as Teacher-Oriented or Student-Oriented. In general, teachers' initial anticipated mathematics teaching style was most similar to the style by which they had been taught mathematics in elementary school. However, no difference was found in initial anxiety for teaching mathematics between those who had been taught in a Teacher-Oriented or a Student-Oriented style in elementary school. Lowest initial levels of anxiety for teaching mathematics were found in those who anticipated teaching in a Student-Oriented style. There was a significant decrease in anxiety for teaching mathematics at the conclusion of the course with the largest decrease among those who changed their anticipated teaching style from Teacher-Oriented to Student-Oriented. Characteristics of the mathematics methods courses are discussed. (Contains 14 references.) (Author)

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Prior Mathematics History, Anticipated Mathematics Teaching Style, and Anxiety for Teaching Mathematics Among Pre-service Elementary School Teachers

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Mathematics History, Teaching Style, and Anxiety

Abstract

The purpose of this study was to assess relationships among prior mathematics educational experience, anticipated teaching style, and anxiety for teaching mathematics. Pre-service elementary teachers (N=28) completed questionnaires measuring the style by which they had been taught mathematics in elementary school, anticipated mathematics teaching style, and anxiety for teaching mathematics (State-Trait Personality Inventory with changed heading) at the beginning of a mathematics methods course. The two latter measures were re-administered at the completion of the course. Teaching style was categorized as Teacher-Oriented or Student-Oriented. In general, teachers' initial anticipated mathematics teaching style was most similar to the style by which they had been taught mathematics in elementary school. However, no difference was found in initial anxiety for teaching mathematics between those who had been taught in a Teacher-Oriented or a Student-Oriented style in elementary school. Lowest initial levels of anxiety for teaching mathematics were found in those who anticipated teaching in a Student-Oriented style. There was a significant decrease in anxiety for teaching mathematics at the conclusion of the course with the largest decrease among those who changed their anticipated teaching style from Teacher-Oriented to Student-Oriented. Characteristics of the mathematics methods course are discussed.

Prior Mathematics History, Anticipated Mathematics Teaching Style and Anxiety for Teaching Mathematics Among Pre-service Elementary School Teachers

Current educational reform emphasizes the way mathematics is taught, in addition to the mathematical content itself (National Council of Teachers of Mathematics, 1989, 1991). Teaching actions, reflected in mathematics teaching style, are viewed as components of mathematics instructional quality (Koehler and Grouws, 1992). Implicit in mathematics teaching style is a conception of the nature of the content and how it is learned (Ernest, 1989; Thompson, 1992). A Teacher-Oriented style reflects "instrumental understanding" (Skemp, 1978) which presents a view of mathematics as a finite domain of facts and rules, with teacher or text as both its source and transmitter. In contrast, a Student-Oriented style reflects "relational understanding" (Skemp, 1978), which views mathematics as comprised of dynamic concepts and procedures that are actively learned and become resources for future situations. A Student-Oriented style rather than a Teacher-Oriented style of teaching mathematics is recommended by mathematics educators (Lampert, 1988; National Council of Teachers of Mathematics, 1989; National Research Council, 1989).

Mathematics History, Teaching Style, and Anxiety

Pre-service elementary school teachers have acquired both content information and a view of mathematics based on their experiences from elementary school through college which shape the way they learn and teach mathematics (Ball, 1990). While mathematics methods courses reportedly impact teaching decisions (Bush, 1989), research also suggests that earlier experiences influence conceptions of mathematics and teaching style (Brown and Borko, 1992). For example, the many years spent observing teaching while learning mathematics as an elementary school student may serve as a model for pre-service elementary teachers. Since there is wide variety in these prior experiences, it is important to examine the extent to which these potentially influential early experiences affect the development of mathematics teaching style. Moreover, these prior experiences may differ considerably from current pedagogical conceptualizations and recommendations.

Choice of teaching style also appears to be related to affective teacher characteristics. In particular, anxious teachers are more likely to teach using a whole-class format focusing on skills rather than concepts, and are less likely to welcome student questions (Bush, 1989). This classroom description resembles a Teacher-Oriented teaching style. Teachers with higher anxiety for teaching mathematics are likely to employ a Teacher-Oriented style.

Mathematics History, Teaching Style, and Anxiety

Anxiety for teaching mathematics (ATM) is an example of the general concern elementary school teachers report regarding their inadequate knowledge about content and their inability to present it effectively to students (Romeo, 1987). One recent study found a significant decrease in anxiety for teaching mathematics among pre-service teachers who participated in a mathematics methods course taught in a Student-Oriented teaching style (Westerback, Levine, and Primavera, 1993).

The relationship between anxiety for teaching mathematics and anticipated mathematics teaching style has not been examined. However, the following model appearas to describe this relationship. Pre-service teachers are likely to anticipate teaching mathematics in the same way that they were taught. Participation in a mathematics methods course which describes and models new instructional practices consistent with those recommended by the National Council of Teachers of Mathematics (1989) is hypothesized to influence the anticipated teaching style of pre-service teachers in a Student-Oriented direction. As anticipated teaching style conforms with these new instructional practices, anxiety for teaching mathematics is expected to decrease.

The present study investigated relationships among the style by which pre-service elementary teachers were taught mathematics in elementary school (ETS), their anticipated mathematics teaching style (ATS), and their anxiety for teaching mathematics

(ATM). It sought to answer the following questions:

1. What is the relationship between anticipated mathematics teaching style at the beginning and at the completion of a mathematics methods course?

2. Does prior educational history influence the anticipated mathematics teaching style of pre-service teachers?

3. Does anxiety for teaching mathematics change from the beginning to the completion of a mathematics methods course?

4. What is the relationship between anticipated teaching style and change in anxiety for teaching mathematics?

Method

Subjects

Participants were 28 pre-service elementary school teachers enrolled in an undergraduate course which presented current methods and materials for teaching mathematics. All were middle class Caucasian females in their early twenties.

Measures

Data were obtained from participants on three self-report measures: History of elementary school mathematics teaching style (HETS), Anticipated mathematics teaching style (ATS), and Anxiety for teaching mathematics (ATM).

Teaching style. Two multiple-choice questions were developed to assess: (1) history of elementary school mathematics teaching style and (2) anticipated mathematics teaching style. The questions were: (1) How were you taught mathematics in elementary school? and (2) How do you plan to teach mathematics in elementary school? Participants indicated the characteristic teaching style in each situation from a list of seven choices: Lecture by teacher, Verbal questions by teacher, Written questions by teacher, Demonstration by teacher, Reading by students, Workbooks/worksheets by students, and Hands on/using material by students.

Anxiety for teaching mathematics. The state anxiety (S-Anxiety) subscale of the State-Trait Personality Inventory (STPI) (Spielberger et al., 1979) was adapted to measure prospective teachers' anxiety for teaching mathematics. This measure includes ten questions, the responses to which are hypothesized to vary with experience. The heading of the questionnaire was changed (C. D. Spielberger, personal communication, 1993) to read "How do you feel about teaching mathematics?" This instrument was deemed appropriate for use in the study since no changes were made in the items, administration, or scoring of the standardized assessment measure.

For each item of the S-Anxiety subscale (e.g., "I am tense;" "I feel nervous;" "I feel frightened"), participants indicated their agreement on a four-point Likert-type scale ranging from

"not at all" to "very much so." As recommended in the manual (Spielberger et al., 1979), scoring weights assigned to each response were summed to yield a score reflecting anxiety for teaching mathematics. A high score indicates a high level of anxiety while a low score indicates a low level of anxiety for teaching mathematics. Alpha coefficients for the S-Anxiety subscale of the STPI have been reported to range between .84 and .93 (Spielberger et al., 1979). In this study, the alpha coefficients were .91 and .80 for the first and second administrations of this measure, respectively.

Procedure

Participants responded anonymously to self-report instruments measuring history of elementary school mathematics teaching style, anticipated mathematics teaching style, and anxiety for teaching mathematics. All scales were group-administered during the first meeting of the mathematics methods course; the latter two measures were re-administered during the last session of the course.

The mathematics methods course met weekly for 2 3/4 hours over a 13-week period. During the course, pre-service elementary school teachers developed strategies for teaching mathematics using an approach that emphasized the following characteristics: examining concepts for understanding, discussing mathematical relationships, and developing representations of abstract

Mathematics History, Teaching Style, and Anxiety concepts and relationships with manipulative materials. Teacher as facilitator was modeled. The five goals for learning and teaching mathematics, recommended by the National Council of Teachers of Mathematics (1989, p.5-6), were discussed and integrated into instructional practices. Ten hours of field work in an elementary school classroom formed part of the course requirement. In addition to developing a lesson plan, students evaluated a mathematics textbook for its compatibility with the five goals for learning mathematics (National Council of Teachers of Mathematics, 1989), kept a journal of their observations and experiences during the field placement, developed mathematics materials, and discussed strategies for incorporating technology into the teaching of mathematics.

Results

For the purpose of data analysis, teaching styles were categorized as either Teacher-Oriented (Lecture by teacher, Verbal questions by teacher, Written questions by teacher, Demonstration by teacher) or Student-Oriented (Reading by students, Workbooks/worksheets by students, Hands on/using material by students). Of the 28 pre-service teachers who completed questionnaires at both the beginning and completion of the mathematics methods course, 17 were Teacher-Oriented and 11 were Student-Oriented. At the end of the course, four were

Teacher-Oriented and 24 were Student-Oriented. Patterns of change are discussed below.

The style with which pre-service teachers were taught mathematics in elementary school was cross-tabulated with their anticipated teaching style at the beginning of the course. As Table 1 shows, 75% of pre-service teachers for whom a Teacher-

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Insert Table 1 about here

Oriented style was most characteristic of the way they were taught mathematics in elementary school anticipated teaching mathematics in a Teacher-Oriented style. Similarly, 60% of those who were taught in a Student-Oriented style anticipated teaching in a Student-Oriented style. These data suggest that in general, pre-service teachers initially plan to teach the way they were taught ($X^2 = 1.88$ with one degree of freedom, not significant at the .05 level).

Initial anxiety for teaching mathematics, measured using the anxiety subscale of the STPI during the first class meeting ranged from 11 to 39, with a mean of 23.57 and standard deviation of 6.96. Final anxiety, measured during the final class session ranged from 13 to 28 with a mean of 19.57 and standard deviation of 4.69. The range of possible anxiety scores can vary from 10 to 40. There was a significant decrease in anxiety for teaching mathematics from the initial to the final meeting of the course

($t_{(27)} = 2.72$, $p < .05$). However, initial and final anxiety scores were not significantly correlated; that is, those pre-service teachers who initially reported the highest levels of anxiety for teaching mathematics did not remain the group with the highest anxiety levels. In an attempt to account for these anxiety shifts considering that anxiety has been related to teaching style, the relationship between change in anxiety and change in anticipated teaching style was examined.

As noted earlier, pre-service teachers were categorized by their anticipated teaching style (Teacher-Oriented or Student-Oriented) at two points in time (beginning of the course and end of the course) and then classified according to their shift (or lack thereof) during the semester. Figure 1 shows mean initial and final levels of anxiety for teaching mathematics for the four

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Insert Figure 1 about here

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groups of pre-service teachers: those whose anticipated mathematics teaching style started out Teacher-Oriented and remained Teacher-Oriented (N= 2), those who started out Student-Oriented and remained Student-Oriented (N=9), those who changed from Teacher-Oriented to Student-Oriented (N=15), and those who changed from Student-Oriented to Teacher-Oriented (N=2). Two striking patterns are evident in these data. First, for the most part, those who initially anticipated teaching in a Student-

Oriented style showed lower initial levels of anxiety for teaching mathematics than those who initially anticipated teaching in a Teacher-Oriented style.[1] Second, those pre-service teachers who initially planned to teach mathematics in a Teacher-Oriented style and changed to a Student-Oriented style had the largest decrease in anxiety for teaching mathematics.

To further examine the relationship between anxiety and teaching style, it was determined that a one-way ANOVA comparing anxiety change across the four groups described above would be more meaningful for this small sample than a repeated measures MANOVA. Results of the ANOVA are presented on Table 2. While there is a strong pattern that approaches significance ($F_{(3,24)} = 2.66$, $p=.07$), the results of this analysis are not significant at the .05 level.

Insert Table 2 about here

Since the group that changed from a Teacher-Oriented to a Student-Oriented anticipated teaching style were of primary interest, one further analysis was conducted. Responses from members of the other three groups were combined to form one group of pre-service teachers who did not change from a Teacher-Oriented to a Student-Oriented teaching style. The change in anxiety level of this composite group was compared to that of the

group that did change from a Teacher-Oriented to Student-Oriented style using an independent groups t-test. The results showed a significant difference in anxiety change ($t_{(19.64)2} = -3.07$, $p<.01$), with the Teacher-Oriented to Student-Oriented group demonstrating a decrease of 7.53 (S.D. = 8.72, n=15) and the composite group showing an increase of .077 (S.D. = 3.77, n=13).

Discussion

This study examined the relationships among prior mathematics history, anticipated mathematics teaching style, and anxiety for teaching mathematics among pre-service elementary school teachers. As predicted, pre-service teachers were most likely to anticipate teaching mathematics in a style resembling the style by which they had been taught in elementary school. Anxiety for teaching mathematics decreased at the conclusion of a mathematics methods course during which instructional practices consistent with recommendations of the National Council of Teachers of Mathematics (NCTM) (1989) were introduced. Lower anxiety for teaching mathematics was reported by teachers who anticipated teaching mathematics in a Student-Oriented style, which is the style consistent with NCTM recommendations. From both a student and teacher perspective, then, these results underscore the value of a Student-Oriented teaching style.

Several questions emerge from this study. First, what was it

about the mathematics methods course that enabled pre-service teachers to change the style with which they planned to teach? Second, why did those pre-service teachers who changed their anticipated teaching style from Teacher-Oriented to Student-Oriented also show a decrease in anxiety for teaching mathematics?

To answer the first question, characteristics of the mathematics methods course will be described. The mathematics methods course emphasized understanding of mathematics concepts through representation and exploration with manipulative materials. In addition, appreciation of the developmental needs of students was underscored. Pre-service teachers were encouraged to create activities and were provided with opportunities to practice them with classmates throughout the semester. A field experience provided exposure to alternative teaching strategies and a final project involved development of a manipulative material that could be used to teach mathematics.

Throughout the semester, pre-service teachers were encouraged to analyze their observations and express their ideas and concerns. The role of teacher as facilitator was modeled. Overall, many teaching perspectives were introduced, obstacles were assessed, and new directions were developed. It seems likely that these experiences supported self-examination of teaching style through which pre-service teachers were able to consider incorporating new ideas in their teaching of

mathematics.

To discuss the second question, perceived expectations inherent in the Teacher-Oriented and Student-Oriented teaching styles will be examined. As described above, a Teacher-Oriented style reflects an instrumental view of mathematics as a set of rules and facts to be transmitted to students (Ernest, 1989). Strict adherence to text, mastery of skills, and compliant learners reflect classroom expectations.

A Student-Oriented style reflects a dynamic and continually expanding view of mathematics (Ernest, 1989). Problem-posing and problem-solving leading to conceptual understanding of material is an important teaching goal. Errors are viewed as useful sources of information, and students are expected to construct mathematical understandings. Since a Student-Oriented style offers a multiplicity of ways to effectively engage students, a pre-service teacher anticipating teaching in this way appears to experience reduced anxiety for teaching mathematics.

The results of this study demonstrate a relationship between mathematics teaching style and anxiety for teaching mathematics among pre-service teachers. Articulation of this relationshp would be facilitated by further investigations that employ a contolled experimental design. Then, cuasal relationship between shifts in teaching style and anxiety for teacign mathematics could be identified.

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Notes

[1] While the group that initially anticipated teaching in a Student-Oriented style and changed to a Teacher-Oriented style had higher anxiety levels, this group included only two people.

[2] Since the variance of the two groups was not homogenous, a separate variance estimate of the t value was needed.

[3] I wish to acknowledge the suggestions of Ellen Brickman, Louis Primavera, LaVergne Trawick, and Mary Westerback in the preparation of this manuscript.

Table 1

Relationship between the style pre-service elementary teachers were taught mathematics in elementary school and their initial anticipated mathematics teaching style

Style taught in elementary school	Anticipated teaching style		
	Teacher-Oriented	Student-Oriented	Row Total
Teacher-Oriented	12 75.0%	4 25.0%	16 61.5%
Student-Oriented	4 40.0%	6 60.0%	10 38.5%
Column Total	16 61.5%	10 38.5%	26[a] 100.0%

Note. [a]Two cases were excluded because of missing data.

$X^2 = 1.88$ with 1 d.f., ns.

Table 2

Anxiety for teaching mathematics change as a function of "anticipated teaching style" group

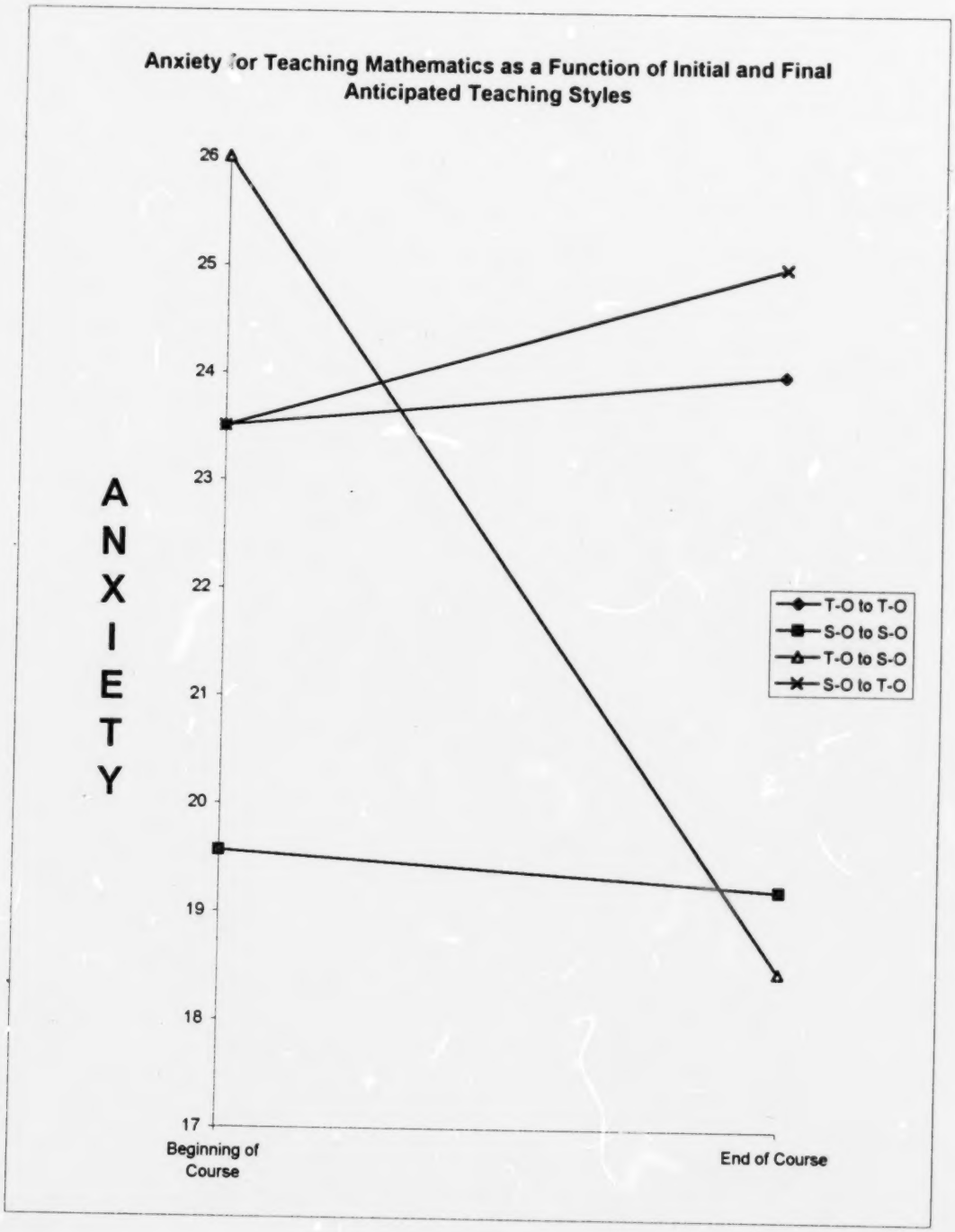
GROUP	MEAN	SD	N
REMAINED T-O	-.50	2.12	2
REMAINED S-O	.33	4.12	9
CHANGED FROM T-O TO S-O	7.53	8.72	15
CHANGED FROM S-O TO T-O	-1.50	4.95	2

$F_{(3,24)} = 2.66$, $p = .07$

Note. T-O = TEACHER-ORIENTED STYLE

S-O = STUDENT-ORIENTED STYLE

Figure 1


Anxiety for Teaching Mathematics as a Function of Initial and Final Anticipated Teaching Styles
ANXIETY
26
25
24
23
22
21
20
19
18
17
Beginning of Course
End of Course
T-O to T-O
S-O to S-O
T-O to S-O
S-O to T-O